Zero-Configuration Networking Using Bonjour

Session 508

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Zero-Configuration Networking Using Bonjour

Dr Stuart Cheshire
Wizard Without Portfolio, Apple
Internet Architecture Board

Outline

- Recap
- Bonjour Sleep Proxy
- Bonjour over unpaired Bluetooth
  - Peer-to-Peer as used by Game Kit
- Other news
- Tips and reminders
- Demos

Recap

TCP/IP over Ethernet and Wi-Fi…

…with the ease of use of USB

Technology

- Link-local addressing
  - IPv4 (RFC 3927)
  - IPv6 (RFC 2462)
- Multicast DNS
  - http://www.multicastdns.org/
- DNS Service Discovery
  - Link-local and wide-area
  - http://www.dns-sd.org/

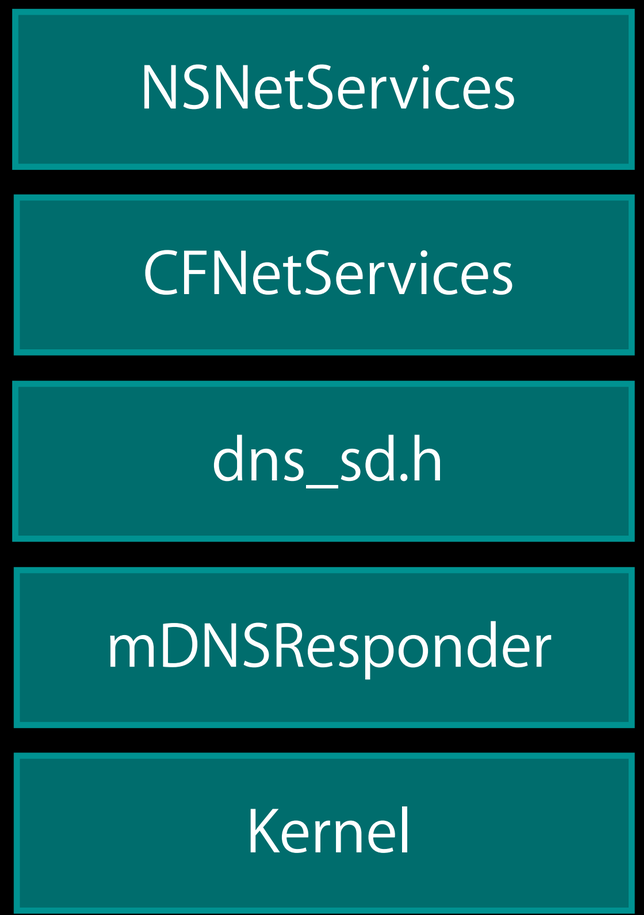
Three Basic Operations

Register

Browse
(Discover Domains and Services)

Resolve

API Architecture



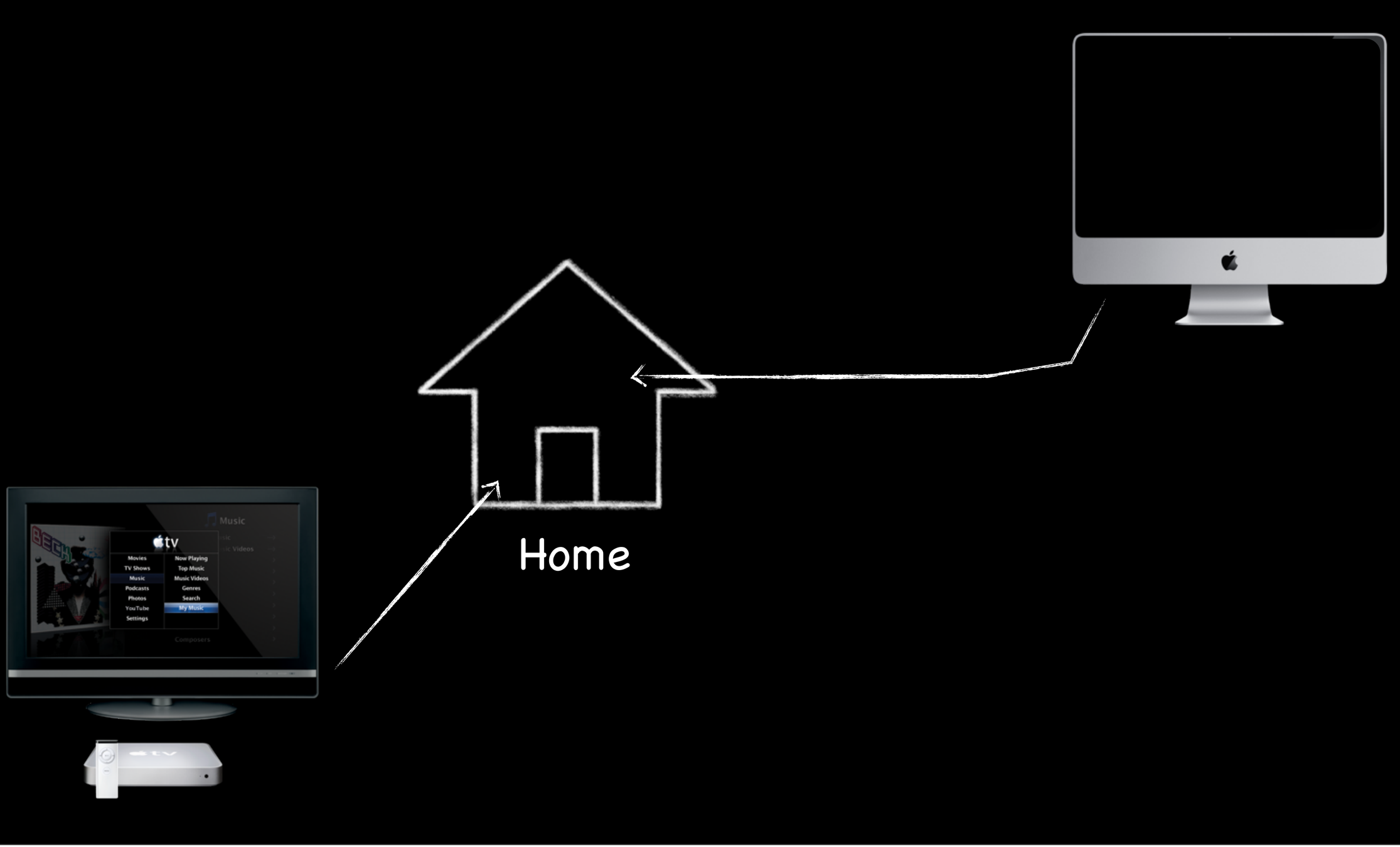
Bonjour Sleep Proxy

Saving the world half a billion dollars worth of electricity a year

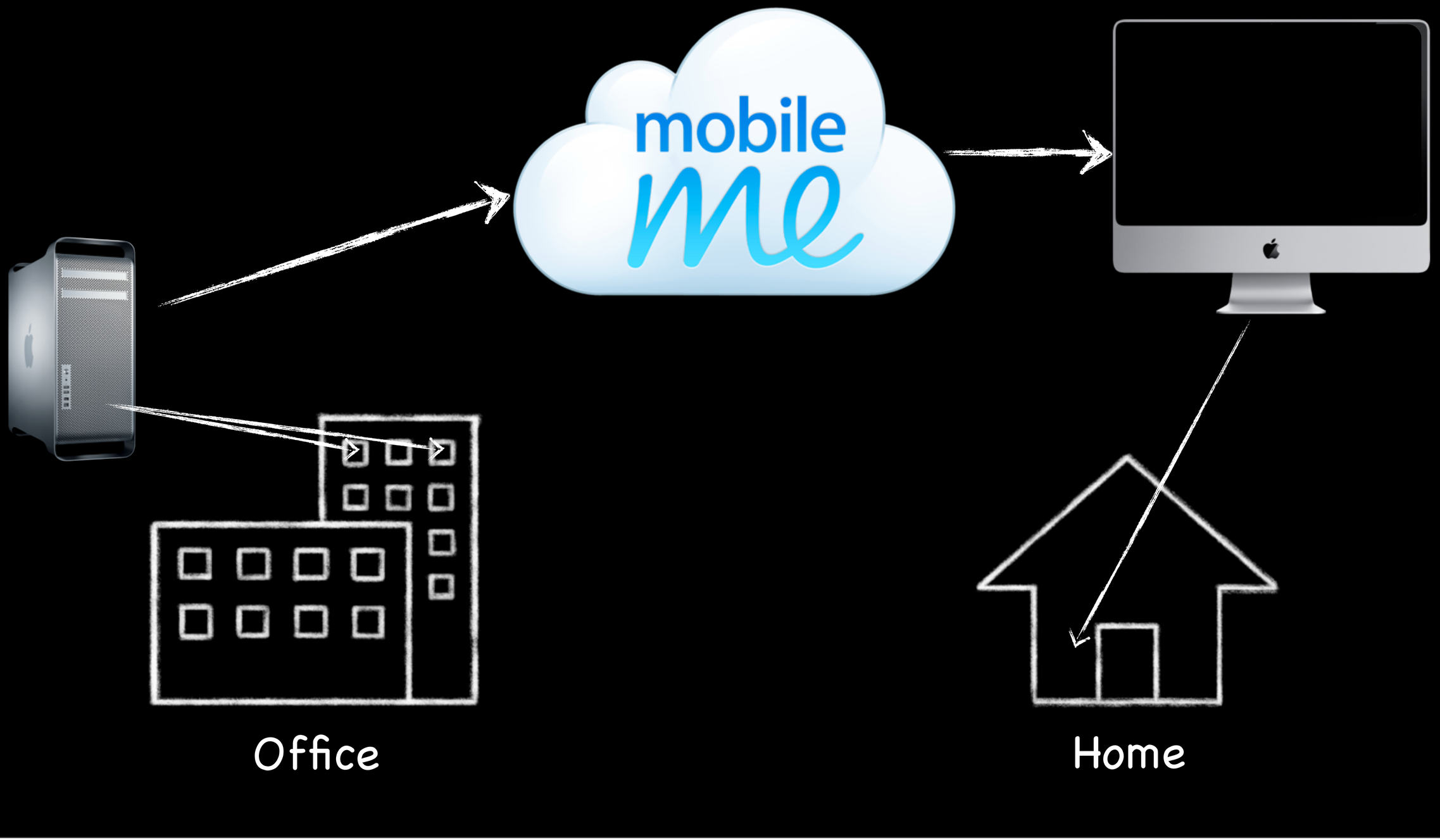
Printing Sleeping Problem

Home

iTunes Streaming Sleeping Problem



Back to My Mac Sleeping Problem

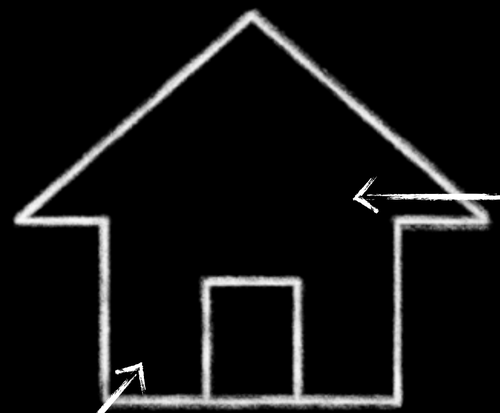


Powerful Solution

Power Saving Solution

Bonjour Sleep Proxy

10.0.0.2



Home

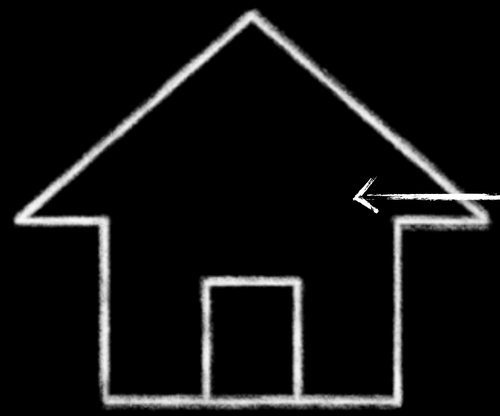
TCP
Automatically
Retransmits

Bonjour
WAKE
Service Records

Connect

Bonjour Sleep Proxy

10.0.0.2



Home

Bonjour
Service Records

Response

Browse

How It Works

- When machine goes to sleep
  - Finds Bonjour Sleep Proxy
  - Registers with Bonjour Sleep Proxy
  - Sleeps
- Bonjour Sleep Proxy
  - Answers mDNS (Bonjour) requests on behalf of sleeping server
  - Answers ARP requests on behalf of sleeping server
  - Captures and inspects incoming traffic for sleeping server
  - Wakes sleeping server with magic packet when required
    - After a few seconds delay, TCP connection completes

Why?

- Printer sharing
- iTunes media
- Back to My Mac screen sharing and file sharing
- Command-line ssh

…and all other Bonjour-advertised network services

Technology

- Magic packet
  - Wake on LAN (Ethernet)
  - Wake on wireless (802.11/Wi-Fi/AirPort)
- Bonjour Sleep Proxy
  - Makes magic packet automatic for all services

Protocol Participants 1 & 2: Server & Proxy

- Sleeping server
  - Bonjour-advertised services
  - Mac OS X 10.6 Snow Leopard
- Bonjour Sleep Proxy
  - Must be on same local link as sleeping server
  - Any always-on device is a good candidate
  - AirPort base station
  - Snow Leopard Internet sharing
  - Open Source, so third parties could offer Bonjour Sleep Proxy too

Protocol Participant 3: The Client

- Anything
  - Mac, Windows, Linux, iPhone, etc.
- Anywhere
  - Local network
  - Global IP
  - Manual default NAT host
  - Manual NAT port mappings
  - Wide-area Bonjour with NAT-PMP
  - Back to My Mac

What Wakes a Machine?

- Incoming unicast UDP packet to Bonjour-advertised service
- Incoming new TCP connection to Bonjour-advertised service
  - Also, for ssh only, incoming data packets:
    - Type “pmset sleepnow” to put machine to sleep
    - Type a keystroke and machine will wake for you

Maintenance Wake

- Periodic lightweight wake to repair network state
  - No screen or audio
  - Disk and fan spinup may be audible
  - Some USB devices may light up
    - Only when connected to AC power
- Fine-grained power management

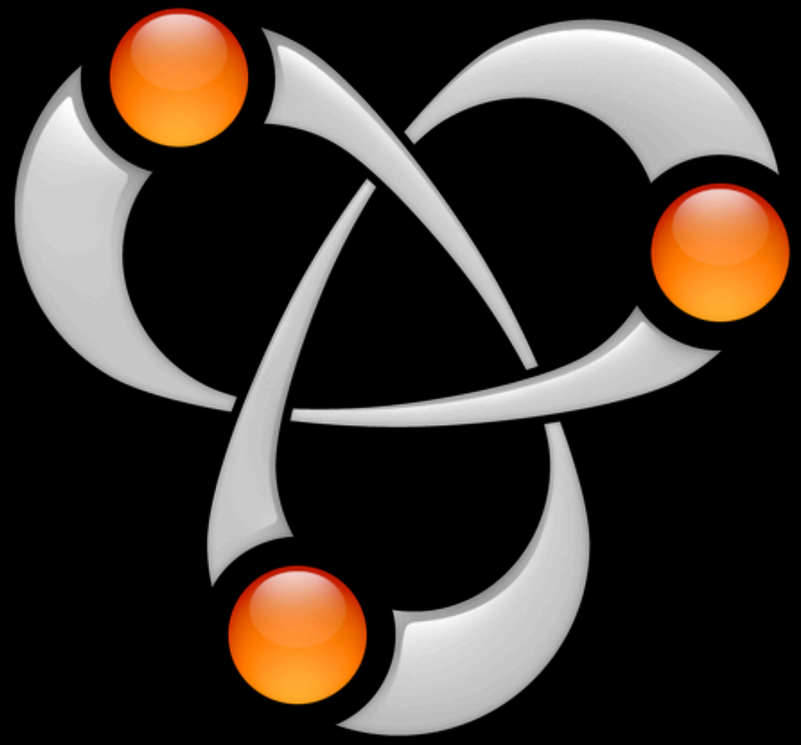
New Power Management Philosophy

- Move away from idle timers
- Software makes active assertions
- Compute set of reasons for my machine to be awake
- When set becomes empty, sleep immediately
- Fine-grained per-component logic
- “Sleep” no longer a well-defined term

Limitations

- USB Ethernet dongle not currently supported
- Wake on wireless
  - Supported on currently shipping models
  - Requires Apple AirPort base station
- Sleeping server must be on AC power
- Sleeping laptops must have screen available
- No IPv6 yet
  - Use “ssh -4 host.local”

What do you need to do?



Bonjour over Unpaired Bluetooth

Rory McGuire
Packet Wrangler, Apple

How does it work?

What does it do?

How It's the Same

- Same APIs
  - NSNetServices
  - CFNetServices
  - dns_sd.h
- Your code will just work

How It's Different

- Resolves may take longer
  - Bonjour automatically brings up Bluetooth PAN
  - So use ResolveWithTimeout: 0.0
    - Let the user decide when they've waited long enough
- That's all!

Browse vs. Resolve

Joe's Printer	joe.local	9100	pdl=application/postscript …	Bluetooth PAN Connection
Sally's Printer	sally.local	9100	pdl=application/postscript …	Bluetooth PAN Connection
Jim's Printer	jim.local	9100	pdl=application/postscript …	Bluetooth PAN Connection
Penny's Printer	penny.local	9100	pdl=application/postscript …	Bluetooth PAN Connection
Paul's Printer	paul.local	9100	pdl=application/postscript …	Bluetooth PAN Connection
Mary's Printer	mary.local	9100	pdl=application/postscript …	Bluetooth PAN Connection

Do the Right Thing

- Browse is distinct from resolve
- Don’t resolve each service
- Don’t connect to each service

Game Kit or Bonjour APIs?

- Game Kit pros
  - Provides nice UI
  - Will ask user to enable Bluetooth
- Game Kit cons
  - Bluetooth only, no Wi-Fi
  - Bluetooth not available in Simulator—use two devices for testing

Bonjour on iPhone OS 3.0

	iPod touch 1st Gen	iPod touch 2nd Gen	iPhone 1st Gen	iPhone 3G	iPhone 3G S
Bluetooth		Yes		Yes	Yes
Wi-Fi	Yes	Yes	Yes	Yes	Yes

Other News

Negative Answers

```
err = DNSServiceQueryRecord(&ref,
      kDNSServiceFlagsReturnIntermediates,
      interfaceindex,
      rrname, rrtype, rrclass,
      qr_reply, contextptr);
```

Single Systemwide DNS Resolver

- Unified DNS cache
- Consistent results
- Disabling mDNSResponder will disable both Bonjour and DNS

Tips and Reminders

Tips and Reminders

- Use asynchronous calls
- No “Refresh” button
- Use windows, not pull-down menus
- Register your service types
- Do not ignore domain
- Do not ignore port number
- License Bonjour logo
  - For hardware devices, pass Bonjour Conformance Test
- License Bonjour for Windows

Use Asynchronous Calls

- DNS timeout is 30 seconds
- iPhone app jettison time is 20 seconds
  - Do a blocking DNS call on your main thread
  - DNS server is slow or unresponsive
  - Your app dies
- CFHost + CFRunLoop
- DNSServiceGetAddrInfo + select, kqueue, Grand Central, etc.

No “Refresh” Button

Browsing lists should always be live

- Safari Bonjour list
- iChat Bonjour buddies
- iTunes sidebar
- Leopard Finder sidebar
- Terminal “Connect to Server…”

Use Windows, Not Pull-Down Menus

- Users comfortable with window content updating
- Traditionally, menus not expected to change once displayed

Register Your Service Types

- Unique identifier for every service type
- 14 characters max
- Letters, digits, and hyphens allowed
- http://www.dns-sd.org/ServiceTypes.html

Do Not Ignore Domain (Local vs. Wide-Area)

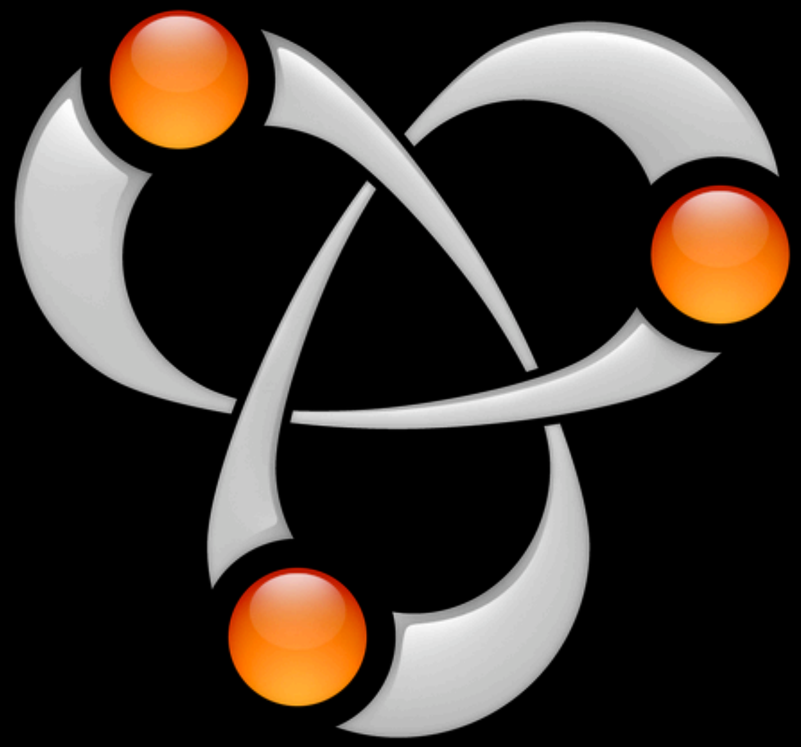
- Browsing
  - With wide-area Bonjour, can discover remote services
  - Service identifed by four-tuple
    - { Name, Type, Domain, interface index }
    - Store at least { Name, Type, Domain }
- Resolving
  - Pass stored { Name, Type, Domain }
  - Don’t pass “local” or empty string for domain
  - Set interface index to zero to search on all interfaces

Do Not Ignore Port Number

- Do not assume well-known port
- Wide-area Bonjour does automatic NAT port mapping
  - Increasingly, services will not be reachable on expected "well-known" port
  - DNSServiceResolve() tells you the port
  - Use it!
  - Example: Terminal "Connect to Server…"

License Bonjour Logo

No license fee



Run Conformance Test

http://developer.apple.com/bonjour/

Finds common mistakes in:

IPv4 Link-Local Addressing

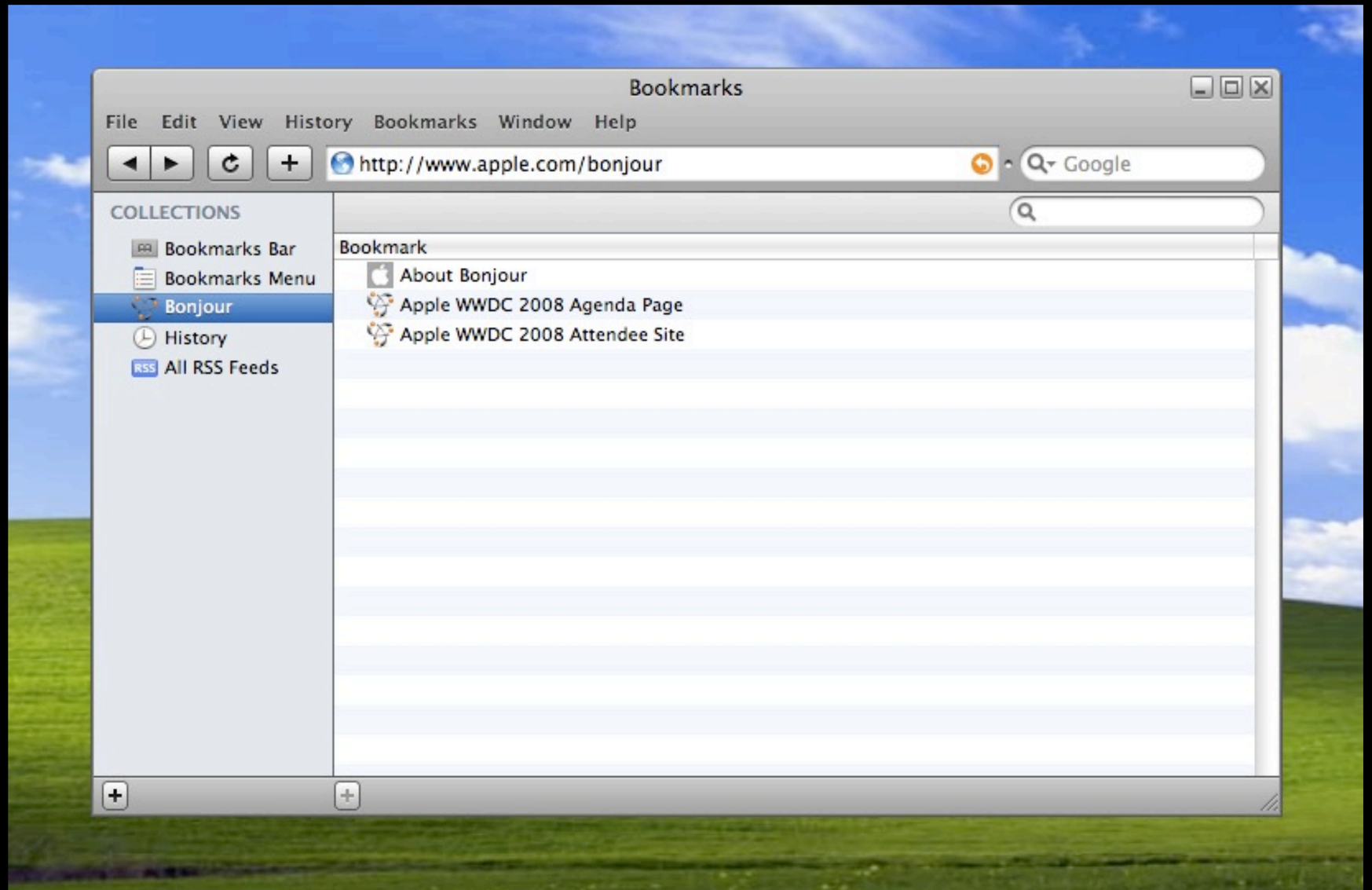
Multicast DNS

DNS Service Discovery

License Bonjour for Windows

No license fee

Safari for Windows with Bonjour



Demos

Demos

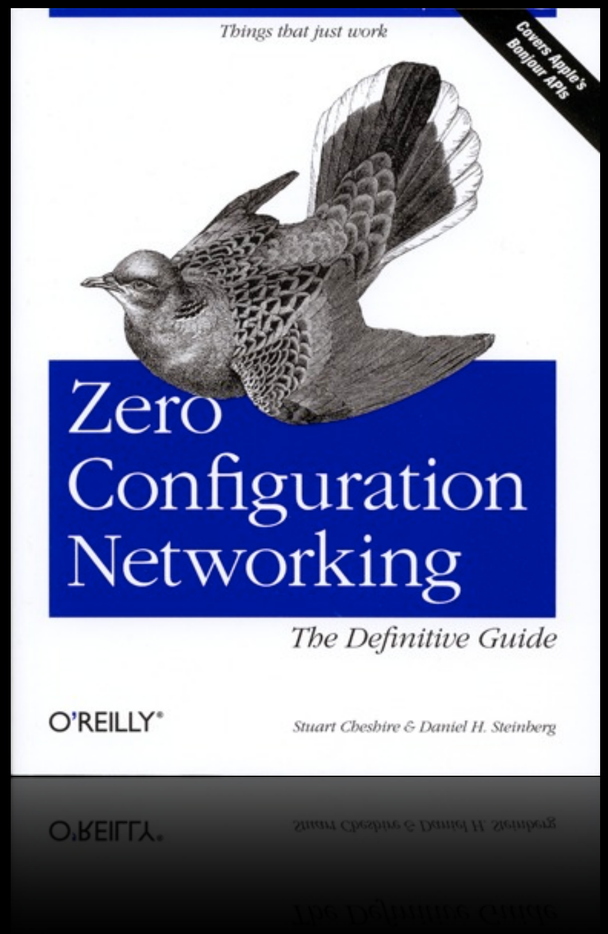
- ZeroG Wireless: Low-cost, low-power Wi-Fi
  - http://www.zerogwireless.com/
- Indigo home automation with iPhone UI
  - http://www.perceptiveautomation.com/
- Zeroconf Spy
  - Download from the App Store

More Information

Craig Keithley
I/O Technology Evangelist
keithley@apple.com

Web Documentation
Bonjour and Zero Configuration Networking
http://developer.apple.com/bonjour/
http://www.zeroconf.org/

Printed Documentation
Zero Configuration Networking: The Definitive Guide
O'Reilly Media, Inc.



Related Sessions

iPhone OS Networking	Russian Hill Tuesday 9:00AM
Peer to Peer Networking with Game Kit	Presidio Wednesday 9:00AM

Labs

Networking Lab	OS X Lab D Wednesday 2:00PM
Game Kit Lab	iPhone Lab D Thursday 9:00AM
Networking Lab	OS X Lab B Thursday 2:00PM

Summary

- Use the Bonjour APIs correctly and you get:
  - The ease of use you already know and love
  - Back to My Mac remote connectivity
  - Bonjour Sleep Proxy automatic wake up
  - Automatic Bluetooth PAN setup

Q&A

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